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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/621,676	07/17/2003	Chen-Hua Yu	252011-1570	1784

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EXAMINER	
SCHILLINGER, LAURA M	
ART UNIT	**PAPER NUMBER**
2813	

DATE MAILED: 02/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/621,676	YU ET AL.	
	Examiner	Art Unit	
	Laura M. Schillinger	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 December 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-30* is/are pending in the application.

4a) Of the above claim(s) *15-29* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) *1-10 and 30* is/are rejected.

7)☒ Claim(s) *11-14* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/17/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Applicant's election of claims 1-14 in the reply filed on 12/06/04 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Claim Objections

Claims 11-14 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim 30 is rejected under 35 U.S.C. 102(e) as being anticipated by Liu et al ('025).

In reference to claim 30, Liu teaches method for fabricating a semiconductor device, comprising:

forming a dielectric layer overlaying a semiconductor substrate (Fig.2A (202));

forming an opening in the dielectric layer (Col.2, lines: 45-47);

embedding copper or copper alloy into the opening (Col.2, lines: 55-60);

forming a silicon layer on the copper or copper alloy (Col.3, lines: 1-5); and

reacting the silicon layer with the underlying copper or copper alloy to form a copper silicide layer capping the surface of the copper or copper alloy (Abs., lines: 1-10).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al ('025), and further in view of Hoshino ('169).

In reference to claim 1, Liu teaches method for fabricating a semiconductor device, comprising:

forming a dielectric layer overlaying a semiconductor substrate (Fig.2A (202));

forming an opening in the dielectric layer (Col.2, lines: 45-47);

embedding copper or copper alloy into the opening (Col.2, lines: 55-60);

forming a silicon layer on the copper or copper alloy by CVD (Col.3, lines: 1-5); and

reacting the silicon layer with the underlying copper or copper alloy to form a copper silicide layer capping the surface of the copper or copper alloy (Abs., lines: 1-10).

However, Liu fails to explicitly teach forming the silicon layer on the copper layer by sputtering as claimed by the Applicant.

However, Hoshino teaches to form a silicon nitride layer by sputtering (Col.3, lines: 45-60).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Liu's teachings to include forming the silicon nitride layer by sputtering as taught by Hoshino, because as Hoshino teaches, either method is suitable to form silicon nitride over copper interconnects (Col.3, lines: 45-60).

In reference to claim 2, Liu teaches a method as claimed in claim 1, wherein the dielectric layer comprises a low-k material having k value less than 3.2 (SRN- Col.1, lines: 10-20).

In reference to claim 2, Liu teaches a method as claimed in claim 1, wherein the dielectric layer comprises organic low-k material, CVD low-k material (Col.2, lines: 25-35)

In reference to claim 6, Liu teaches a method as claimed in claim 1, wherein the silicon layer comprises amorphous silicon (silicon nitride is an amorphous silicon).

In reference to claim 8, Liu teaches a method as claimed in claim 1, wherein the copper or copper alloy is formed by the steps of: depositing a copper seed layer in the opening; and electro-chemical plating or electroless plating the copper or copper alloy on the copper seed layer (Col.3, lines: 15-25)

In reference to claim 9, Liu teaches a method as claimed in claim 1, wherein the copper or copper alloy is formed by chemical vapor deposition (Col.3, lines: 20-25).

In reference to claim 10, Liu teaches a method as claimed in claim 1, wherein the copper silicide layer is formed by subjecting the semiconductor substrate to an inert gas-containing ambience at a temperature of about 150 degrees C. to about 450 degrees C (Col.2, lines: 25-30).

In reference to claims 4, 5, and 7 Liu fails to explicitly teach a method as claimed in claim 1, wherein the width of the opening is less than 900A; wherein the thickness of the embedded copper or copper alloy is less than 4000A; and wherein the thickness of the silicon layer is 50 to 500A.

However, these claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ2d 1935, 1937 (Fed.

Cir. 1990). See also In re Huang, 40 USPQ2d 1685, 1688(Fed. Cir. 1996)(claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and In re Aller, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

Allowable Subject Matter

The following is a statement of reasons for the indication of allowable subject matter: In reference to claim 11, prior art of record fails to teach nor suggest the limitations of claim 1, further comprising the steps of : removing un-reacted portions of the silicon layer; and forming a diffusion barrier layer overlaying the copper silicide. Consequently, claim 11 is deemed to contain allowable subject matter. Claims 12-14 depend from claim 11 and therefore are also deemed to contain allowable subject matter for identical reasons.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Laura M. Schillinger whose telephone number is (571) 272-1697. The examiner can normally be reached on M-T, R-F 7:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl W. Whitehead, Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

LMS

02/03/05